ELECTRICAL RESISTANCE TOMOGRAPHY FOR STRUCTURAL HEALTH MONITORING OF NANOCOMPOSITE MATERIALS FOR SPACESUIT AND CREW SURFACE MOBILITY APPLICATIONS

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Electrical Impedance Tomography (EIT) is an unobtrusive and portable monitoring method allowing the reconstruction of the electrical conductivity in a 2D domain of interest, from the voltage measurements of electrodes positioned along the boundary of the domain. Electrical conductivity changes can be correlated to damage. EIT has been used in biomedical engineering applications (e.g. to monitor the brain function as a patient loses consciousness from anesthesia, [1], and for structural health of advanced composite materials subject to mechanical damage (e.g. [2]). More recently, using Electrical Resistance Tomography (ERT), based on DC injection, we have characterized the health of nanocomposite sensors applied onto the surface of carbon fiber-reinforced polymer composites [3]. The films were prepared with graphene nanoplatelets and DNA. The samples were subjected to two levels of UV-C radiation (2.6 and 4.0 mW/cm^2), for 24 hours, causing varying levels of damage that were studied also with Scanning Electron Microscopy. We proved that the electrical conductivity changes of the films under UV-C irradiation can be well captured by the ERT maps, with accuracy depending on DC current levels and injection patterns.

We plan to adapt these methods to the REVEALS (Radiation Effects on Volatiles and Exploration of Asteroids and Lunar Surfaces) project: in particular, for the health monitoring of nanocomposite samples designed synergistically for radiation resistance and electrical conductivity, to be incorporated in spacesuit and surface mobility applications. We envision the material to be compliant sufficiently to be applied around the body to protect the most important organs. The first materials to be tested will be modified polymers consisting of medium density polyethylene treated with graphene nanoplatelets, which could also be eventually 3D-printed. Different types of damage are envisioned for this study, from mechanical damage to UV-C damage to damage to other radiation types. Residual mechanical properties will be measured directly with mechanical testing or indirectly with measurements of Shore D hardness.

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